others. It is, besides, the brightest of them all. Extensive investigations published on this subject cannot, however, be said fully to elucidate the question why the other lines of nitrogen do not appear in the spectrum, nor do physicists agree as to the temperature and density which, under these circumstances, must be supposed in the nebulæ. It is, besides, precarious to draw from phenomena observed in Geissler's tubes conclusions as to circumstances prevailing in the vast nebulæ (Zöllner, *Berichte der k. sachsischen Gesellschaft d. Wissensch*, for 1870, p. 254). It appears less important that nobody has been able to comply with Angström's demand when he says ("Recherches sur le Spectre solaire," p. 37):—"This line is double. . . . It appears, therefore, that we ought to be able to show this duplicity in the corresponding line of the nebular spectrum." To their separation is required too narrow a slit for the feeble light of the nebulæ. All considered, nitrogen is at present very likely one of the constituents of nebulæ.

The origin of *Neb.* (2) is not known. The idea at first occurred to Huggins of one of the many barium-lines, but he soon gave this idea up. One of the iron lines holds exactly its place; it is a dark line, but not one of the principal of the rich spectrum; of course this coincidence is accidental. This line is again met with in the spectrum of many red and variable stars. The measures of Vogel (*Ber. d. k. sachs. Gesellsch. d. Wissensch.*, 1871, December 17) agree well enough with the gaseous line when the great difficulties of the cases are taken into account. *Neb.* (2) does *not* occur in the spectra of comets.

Neb. (3) is identical with the line Hβ of hydrogen, whose existence in gaseous nebulæ was proved when Huggins discovered Neb. (4), which is Hγ, that was so long sought for in vain. Hydrogen is everywhere found as one of the constituents of the heavenly bodies, but the comets contain no traces of it. The hydrogen-lines appear even in the spectra of many fixed stars, at least through Hα and Hβ, but sometimes Hβ and Hγ are the strongest (β Lyræ), and three hydrogen lines are distinctly seen in the spectra of α Aquilæ and α Lyræ.

D'Arrest then gives in his paper a list of all the nebulæ which have been spectroscopically examined by himself or others.

He speaks first of the gaseous nebulæ, of which H. iv. 37 is the most remarkable; then he mentions those whose spectra are continuous, and thus proved to be mere conglomerates of stars. The latter are by far the most difficult to examine, the feeble light being distributed over a large space, and generally minima visibilia. An astronomer well versed in the use of the spectroscope is, however, often able to decide whether the spectrum is continuous, even if it be not visible by glimpses. Already the absence of the spectrum may occasionally hint about the true nature of the body. He estimates the number of nebulæ known in the middle of 1872 to be about 6,000; of these 150 have been examined with the spectroscope. It is, therefore, only the fortieth part, which is bright enough to be seen through the system of prisms. Although it is hardly possible to draw conclusions from so small a fraction of the whole, still d'Arrest thinks it possible, on account of the critical revision he has given the observations, to arrive by induction at a few results. He finds that of a given number of nebulæ about a fourth give the discontinuous spectrum, while three-fourths give the continuous.

Gas nebulæ are, with but few exceptions, known by their green-blue light, their sharply-defined, round, or elliptic discs with annular bright condensations inside. There are, however, large, extensive, irregular, and complicated nebulæ, which also consist of the three gases, nitrogen ever foremost, though the gases are mixed in different proportions. The very feeble continuous spectrum which appears in many planetary nebulæ can in most cases be shown to arise from the consolidated nucleus, the fluid or solid central mass. The distribution of brightness in extensive nebulosities is very irregular, and the heat in certain regions rises and falls occasionally a little, though no real alterations in the form are known as yet.

The ray-nebulæ are surely mere conglomerations of stars. Those are the long, lenticular nebulæ, often so narrow and fine that such an object may resemble a thin bright line drawn through the nucleus. No such nebula is hitherto known to give a tri-chromatic spectrum.

It was in 1866 that Secchi commenced to examine red stars with remarkable broad bands in the spectra, and he was already, in 1868, compelled to add a fourth class to his three classes of star-spectra. A systematical search after remarkable star-spectra was undertaken in 1873 and following years in Copenhagen. D'Arrest's four papers in *Astronomische Nachrichten* contain only the most remarkable of those he found, and only such as had not previously been mentioned. That most are above the eighth magnitude is evidently only founded on the difficulty of seeing spectra of smaller stars.

The circumstance which Secchi remarked in 1868, that yellow and red colours are so often connected with prominent spectra, seems certainly to be of importance, but the many exceptions should warn us from here expecting any great cosmical law. Neither is their connection with variability a rule without exceptions. There are many strongly coloured stars with very indifferent spectra.

Most of the spectra described are of the third class. These are not uncommon, for when we examine 140 stars we may expect to find one of the third class. They are uniformly distributed over the sky, and found also by white stars. The character of spectra of this class is constant throughout. The positions of the dark bands were also shown by Vogel, in 1872, to be the same for four bright stars. The columns are generally more distinctly separated towards the red end of the spectrum, though the contrary occurs also, and it is even possible to follow the steps from but finely-indicated bands to absolute discontinuity, but the colour has nothing to do with these gradations.

Still more intimately connected with orange colour is the fourth class, and specimens of this class are, in consequence, very uncommon. D'Arrest ascertained that the dark bands in the star-spectra are formed by groups of compressed dark lines against Secchi's experience. He examined spectra of stars with great proper motion, and found, for instance, the spectra of 61 Cygni and 1830 Groomb. to be indifferent, uniform, and continuous. General similarity of the spectra in certain parts of the sky does not exist at all, or has not been proved yet; for instance, it is not true that red and yellow are wanting in the spectra of small stars in Orion.

W. D.

THE PROGRESS OF METEOROLOGY[1]

AT the opening of his address Dr. Neumayer regretted that the general knowledge and public appreciation of meteorology was still very small in comparison with that of other branches of science. The main object of his address was therefore to induce his hearers to do all in their power to effect a more perfect and detailed understanding of this branch of science among their countrymen in their respective spheres of activity. He treated the subject, and particularly the weather-forecasts, mainly from his own point of view as a naval officer, and pointed out how desirable a greater interest in marine affairs would be in all circles of German home life. The course which meteorology in its application to daily life has taken may be divided into two categories of observations, first the uninterrupted systematic meteorological investigations, and second, the atmospheric disturbances or phenomena governed by the laws of winds, as first described some fifty years ago by Prof. Dove. He then gave a sketch of the progress of meteorology in other countries; of the establishment of the numerous meteorological stations, and the application of telegraphy to this science; of the enormous help afforded by the introduction of rapid means of communication. He pointed out how the greatest progress was made by the United States of North America; that England was second in this respect, and was followed by Holland, France, and Denmark. According to the latest news, the yearly budget for meteorological observations in the United States was raised from 250,000 to 450,000 dollars, apart from all personal expenses. The rise in this sum is explained by the necessity of having special telegraph wires and stations solely for the meteorological service and by the increase in the staff of observers. If in Europe the practical results of observations are not quite as satisfactory as might be desired, it is because the European organisation of the meteorological service is far more imperfect than the American one. The German Government has given its full attention to this important science, particularly with regard to the German navy and the coast population. The poor German fishermen in the Baltic and the German Ocean are already deriving great benefit from the numerous meteorological stations which have been established along the German coast-line, although it is only eighteen months since the service has begun. The German "Seewarte" has been established and now performs its share of international work along with the sister-establishments of England, Holland, and France. Agriculturists will

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[1] Meteorology in Daily Life. Address delivered at the meeting of the German Association at Munich, by Dr. G. Neumayer, Director of the Deutsche Seewarte at Hamburg.

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derive equal benefit from the meteorological service if inland stations are established and care is taken that the general population of the country are taught how to appreciate their work. Dr. Neumayer concluded with the sentence :—It is not only the duty of the State to found beneficial institutions and to organise them efficiently, it is also the duty of the State-citizen to learn to understand and to appreciate these institutions and to enter into this spirit of the work they are called upon to perform.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

St. Andrew's.—The Senatus Academicus of St. Andrew's University have conferred the degree of LL.D. upon Mr. Henry Woodward, F.R.S., of the British Museum, and Dr. W. C. Macintosh, of Murthly, well known for his researches on British annelides.

The Yorkshire College, Leeds.—Mr. Arnold Lupton, F.G.S., has been elected Instructor of Coal Mining, a department recently endowed by the Drapers' Company of London.

Higher Education of Women.—A public meeting composed for the most part of ladies, was held on the 6th instant in the Vestry Hall, Kensington, to inaugurate the system of lectures for the higher education of women, undertaken by the Principal and Professors of King's College with the co-operation of the Women's Educational Union. The object of the lectures, which commenced on the 11th instant, is to supplement and continue school education, and the instruction will have, as far as possible, reference to the examinations open to women in the University of London or elsewhere. The minimum age of students is fixed at 17, except in such cases as receive the special sanction of the committee. The classes will be at present held in the Vestry-hall, High Street, Kensington. The curriculum embraces Holy Scripture and Church history, logic and moral philosophy, modern and ancient history, the English, Latin, French, and German languages and literatures, mathematics, mechanics, and botany. Experimental physics, chemistry, and drawing will also be taught as soon as suitable arrangements can be made. Other classes, if necessary, will also be formed. The fees vary from 10*s.* 6*d.* to 2*l.* 2*s.* per term ; for any four complete courses they will 6*l.* 6*s.* For ladies engaged in teaching there will be a remission of 25 per cent.

Prizes in Botany for Young Women.—The Society of Apothecaries of London announce their intention to award prizes to young women students in botany for proficiency in that science, the prizes to be competed for under the following conditions :—The competition will be open to all young women who shall produce from their teachers certificates that their age at the time of examination does not exceed twenty years. The examination will be in general and not medical botany. It will consist of questions both written and oral, in—(1) Structural Botany ; (2) Vegetable Physiology ; (3) Description of Living Plants ; (4) Systematic Botany ; so far as these subjects are contained in Sir Joseph Hooker's "Science Primer—Botany," and in Prof. Oliver's "Lessons in Elementary Botany." The first examination will take place in London on the third Wednesday and the third Friday in June, 1878. Candidates will be required to send their names and their residences, at least fourteen days before the examination, to the Beadle, Apothecaries' Hall, Blackfriars, E.C., when they will receive tickets of admission to the examination.

France.—M. Bardoux, the French Minister of Public Instruction has taken preliminary steps for organising at Paris on the occasion of the Universal Exhibition, a great congress of schoolmasters. A delegate from each district will be sent by his fellow-teachers. Not less than 4,000 are expected to be present.

M. Bardoux has again taken up in the French Chamber the proposed erection of new schools in France. M. Waddington was the originator of the scheme. It is intended to build no less than 17,320 new school-houses, and purchase, enlarge, or restore 12,000 others.

SCIENTIFIC SERIALS

Verhandlungen der k.k. zoologisch-botanischen Gesellschaft in Wien (vol. i., 1877).—This volume contains the continuations of, and additions to, several important papers commenced in the volumes for previous years. We mention particularly the mycological researches by Herr Schulzer von Müggenburg.—The other papers, of which some are very elaborate, are :—On *Cecidomyidæ*, by Dr. Franz Löw.—On the Diptera genus *Medeterus*, Fischer, by F. Kowarz.—On the fungus flora of Vienna, by W. Voss.—On some spiders from Madagascar, by Count E. Keyserling.—On some American spider genera from the families *Pholcoidæ*, *Scytodoidæ*, and *Dysderoidæ*, by the same.—On the *Holothuria* fauna of the Mediterranean, by Dr. Emil von Marenzeller.—On *Psyllodæ*, by Dr. Franz Löw.—On the *Chalcidiæ* genus *Olinx*, by Dr. Gustav Mayr.—Coleopterum, species novae, by E. Reitter.—On the passage of *Pastor roseus* (Temm.) through Austria, Hungary, and the neighbouring countries in 1875, by V. von Tschusi.—Ornithological notes, by B. P. Hanf.—On the flora of Southern Istria, by I. Freyn.—On the lepidoptera fauna of the Dolomite district, by I. Mann and A. Rogenhofer.—On the coleoptera fauna of Central Africa, by P. V. Gredler.—The volume concludes with an interesting description of the piscicultural establishment of Herr A. Fruwirth at Freiland, near St. Pölten (Lower Austria), by Dr. E. von Marenzeller.

Memorie della Società degli Spettroscopisti Italiani, May, 1877.—A note on the solar eruptions during 1876, by Prof. Tacchini. Number of days of observation, 106 ; number of eruptions, 9, two on eastern limb and 7 on western limb.—Note by the same author on the present solar phenomena as compared with those during the maximum spot period ; the number of eruptions observed at Palermo in 1871 were 97, while only one was seen in the first four months of this year.—Letter from Father Secchi to Prof. Tacchini on the above subject, also a letter between the same persons relative to Winnecke's comet.—Drawings of solar prominences for January and February, 1876, accompany this number.

June.—Note on a water-prism, by Father Secchi. Path of solar protuberance observed at Rome in April, 1877 ; same for May.—Note by Prof. Tacchini, on a metallic solar eruption seen in June last ; the following lines were visible in the spectrum : b^1, b^2, b^3, b^4, 1474*k*, 4923*A*, 5017*A*, sodium, 5369*A*.

July.—Continuation of the above note.—Note by Prof. Millosevich, on the contact of Mercury with the sun's chromosphere on May 6, 1878.—Drawings of the chromosphere for the months of March, April, and May, 1876, accompany this number.

August.—Note on the zodiacal light, by Prof. Serpieri.—Announcement of the death of Eduardo Heis.—Description of a new form of gravity escapement, by Prof. Young.—The spectroscopic drawings of the chromosphere for June and July, 1876, accompany this number.

September.—A paper on the discovery of oxygen in the sun by photography, and a new theory of the solar spectrum, by Prof. H. Draper. [This discovery, and all matter relating thereto, have already been fully reported in our columns.]—Table of solar protuberances observed at Rome in June, 1877.—Table of solar spots seen at Palermo in July and August, 1877. Four maps, together with a preface by Prof. Heis explaining them ; the maps are of a portion of the heavens adjoining the ecliptic, and show stars down to the fifth magnitude, and they are for use in determining the position of the zodiacal light.

Journal de Physique, January.—On the employment of rotating discs for the study of coloured luminous sensations, by M. Rosentiehl.—On the use of the radiometer as an apparatus of demonstration, by M. Violle.—Rheostatic machine, by M. Planté.—Experimental researches on the interferences of light, by M. Righi.

SOCIETIES AND ACADEMIES

London

Royal Society, January 10.—"On the Structure and Development of the Skull in the Common Snake (*Tropidonotus natrix*)," by W. K. Parker, F.R.S.

"Observations on the Nervous System of *Aurelia aurita*," by Edward Albert Schäfer, Assistant-Professor of Physiology in University College, London. Communicated by W. Sharpey, M.D., LL.D., F.R.S.

January 24.—The Cortical Lamination of the Motor Area of the Brain," by Bevan Lewis, F.R.M.S., Pathologist and Assist. Med. Officer to the West Riding Asylum, and Henry Clarke, L.R.C.P. Lond., Med. Officer to the West Riding Prison.

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